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Provost

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[54] HOOK FOR HOOK AND LOOP FASTENERS

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[52] U.S. Cl. 24/452; 24/442; 24/449

[58] Field of Search 24/452, 451, 450, 449, 24/442, 448

[56] References Cited

U.S. PATENT DOCUMENTS

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3,154,837	11/1964	De Mestral	28/72
3,312,583	4/1967	Rochlis	161/62
3,708,833	1/1973	Ribich et al.	24/204
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4,894,060	1/1990	Nestegard	604/391
4,984,339	1/1991	Provost et al.	260/474
5,058,247	10/1991	Thomas et al.	24/452
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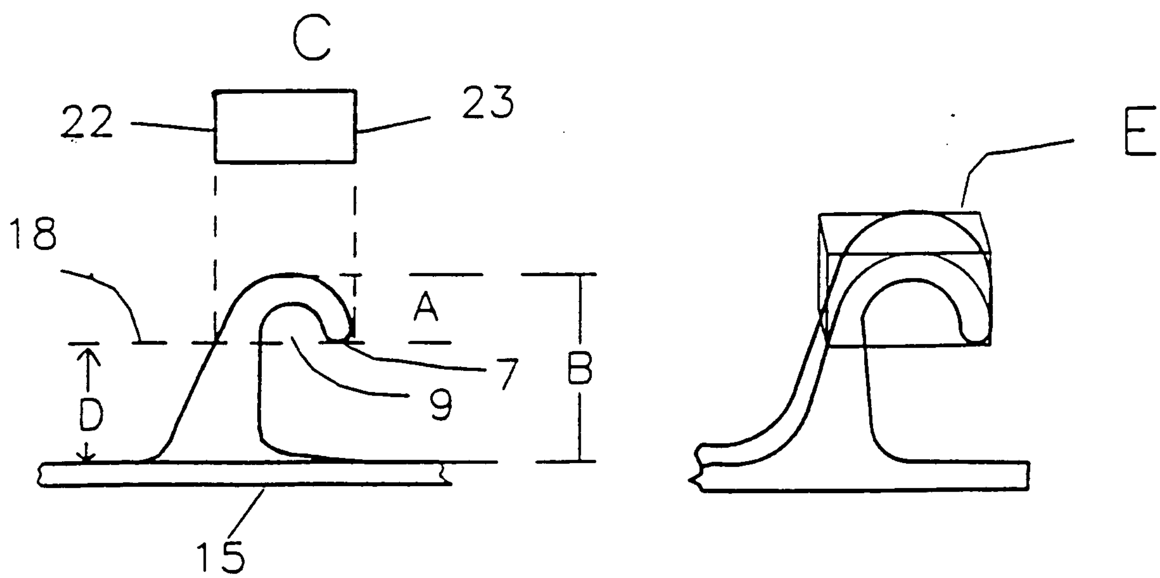
[57] ABSTRACT

A plastic molded hook for use with a hook and loop fastening system especially adapted for use with low profile loops. The hook design includes a base, a stem and a crook whereby the volume of the portion of the hook penetrating into a pile of loops is defined as the displacement volume. Hooks especially adapted for use with low profile loops have a displacement volume of less than 6×10^{-6} cubic inches.

15 Claims, 3 Drawing Sheets



REISSUE APPLICATION

FOR

UNITED STATES LETTERS PATENT

TITLE: **HOOK FOR HOOK AND LOOP FASTENERS**

APPLICANT: **GEORGE A. PROVOST**

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KYRA MARCHE

HOOK FOR HOOK AND LOOP FASTENERS

BACKGROUND OF THE INVENTION

This invention relates to an improved hook for hook and loop fasteners and particularly to plastic molded hooks intended for use with low pile loops. The technology of hook and loop fasteners is well known wherein a fastener comprised of two separable pile fastening tapes having interengaging piles on their surfaces, one pile having loop-elements and the other hook elements, are capable of co-acting to form a separable bond.

Such pile fasteners have found a wide variety of uses where ease of opening and closing is desirable such as in clothing, footwear, home furnishings, medical products, automotive fastening and many other industrial situations where detachable or permanent engagement is required. U.S. Pat. No. 3,009,235, U.S. Pat. No. 3,083,737 and U.S. Pat. No. 3,154,837 disclose various forms of separable pile fastener tapes constructed from fibrous forms of synthetic polymers such as nylon using basic textile weaving techniques. Such methods create a base fabric into which is woven the pile surface capable of engaging to form the closure. In more recent times special hook materials have been made from plastic molding techniques wherein the hooks are integrally formed with a base strip as the tape is being formed.

U.S. Pat. No. 3,031,730 describes a closure wherein a surface of burr like elements are exposed on a surface to be positively coupled with a fabric. The burr like elements are in the form of cast or molded flexible or plastic hook like members.

U.S. Pat. No. 3,760,000 to Menzin discloses a hook "eye" having a sloping surface which functions as a cam surface for extracting the molded hook from its mold cavity. The shank surface has two flat sides of equal dimensions and a somewhat larger third side. The shank portion is larger in cross section nearer the web than at the tip of the hook and the three flat side portions of the shank are continuous in smooth curves into and throughout the hook portion with the shank portion of the three sides laying in the same continuous plane as the corresponding face of the hook portion. U.S. Pat. No. 3,312,583 to Rochlis and U.S. Pat. No. 3,708,833 to Ribich describe other embodiments of hooks having somewhat tapered shapes. U.S. Pat. No. 3,913,183 to Brumlik describes a self gripping device wherein the gripping elements are particularly adapted for self gripping fibers and the like along the entire length of the fibers.

U.S. Pat. No. 4,894,060 to Nestegard describes a hook design for a disposable diaper with an improved hook fastener portion wherein the hook is made by the technique of extruding a profile and subsequently slitting the profile to form discrete hooks. The Nestegard patent claims a hook of sufficiently small dimensions for engaging with low cost loops, particularly loops created by the nonwoven process. The hook shape of the Nestegard patent is considerably different than those of the instant invention because of the method of making the hooks wherein one is dependent upon a continuous profile prior to the cross cutting process. The dimensions disclosed and claimed in the Nestegard patent are not sufficient to calculate a displacement volume.

Even more recently U.S. Pat. No. 4,984,339 to the inventors of the instant application discloses an improved hook having a profile defined by an inner,

smoothly contoured, generally concave face and an outer, generally convex face, wherein the hook tapers smoothly and continuously downward in width from a sturdy base member to its free end whereby the hook will not deform to release a loop engaging the hook in shear at or below the desired applied force.

While the hooks formed according to these patents posses many useful properties and engage with a wide range of loop constructions, they possess the limitations of many other prior art hooks in their inability to function effectively with very low profile loops constructed with very short individual loops. Such loops are especially desirable because of their thinness and their low cost. In some case such loops are laminated to thin layers of polyurethane foam to provide a resilient base so that hooks can more easily penetrate into the body of a pile and thus be more easily surrounded by loops. In general, however, such loops do not function well with conventional hook structures.

One exception to the above described phenomena is the so-called mushroom hook. Mushroom hooks are produced by a variety of processes. Details of these types of products are contained in U.S. Pat. Nos. 3,138,841, 3,770,359, 4,024,003 and 4,290,832. Generally the steps include creating an upstanding filament of polypropylene monofilament and melting the top of the monofilament with heat which causes molten polymer to "melt back" or flow down the stem in a blob which solidifies at the terminal end of the filament to form a mushroom shape head on top of the stem. The mushroom head acts as do hooks of conventional hook and loop fasteners by entangling with loops to form a bond. Because of its small footprint, which will be discussed more fully below, mushroom fasteners are able to engage readily with lower pile loops than other hooks of the hook and loop type. However, mushroom products have many disadvantages. They are limited to use of orientated polypropylene fibers with associated limitations of that material, such as a relatively low temperature operating range. The mushroom heads are easily snapped off their stems giving such products very limited life in use, and the mushroom head does not have the flexing capability of a hook shape and therefore the only way a loop can be removed from the head is to rupture either the loop or the mushroom head. Other limitations of mushroom products are well known to those in the art.

SUMMARY OF THE INVENTION

The present invention contemplates producing a hook from the method described in U.S. Pat. No. 4,794,028 to Fischer in which both the size and shape of the hook is especially suited to low level loops. It has been found that outstanding and unexpected performance from such hooks in low level loops is possible. It is further realized that the selection of the appropriate resin greatly enhances the performance of such hooks. More specifically I have found that a hook produced with a displacement volume, discussed more fully below, of less than 6×10^{-6} cubic inches and preferably a displacement volume of less than 4×10^{-6} cubic inches will provide unusual and outstanding performance with a loop of the lowest loop configuration. Displacement volume, as defined herein, is the volume of a rectangular parallelepiped which delineate the volume of loop displaced when a hook penetrates into the loop to just the point where loops may start to fall into the cavity at

the inside of the crook of a hook, as will be more fully appreciated from the description below.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross section of a hook of a conventional textile hook and loop closure system.

FIG. 2 depicts the hook of FIG. 1 as it would look engaging into a deep mat of loops in a standard loop strip of a hook and loop closure where the loop height is great relative to the return height of the crook.

FIG. 3 depicts the hook of FIG. 1 engaging a low profile loop where the return of the crook is greater than the height of the loops.

FIG. 4 is a cross section of a plastic molded hook as described in the prior art.

FIG. 5 depicts the hook of FIG. 4 as it would look engaging into a mat of loops in a standard loop element of a hook and loop closure where the hook is engaged with a single loop.

FIG. 6 depicts the hook of FIG. 1 showing the profile of displacement, or footprint, required when the hook penetrates into a mat of loops to a position equal the height of the loops.

FIG. 7 is the cross section of a mushroom hook showing the profile of displacement.

FIG. 8 depicts the hook of FIG. 4 showing the profile of displacement.

FIG. 9 is a cross sectional profile of a hook shape of the present invention and shows the profile of displacement for that hook.

FIG. 10 is the cross section of the hook of the present invention showing the profile of displacement.

FIG. 11 is a three dimensional illustration of the parallelepiped which is defined as the displacement volume.

FIG. 12 is a graph depicting the relationship between shear strength and hook displacement volume for a low profile loop.

BEST MODE FOR CARRYING OUT THE INVENTION

Now referring to FIG. 1, a monofilament(1) strand is bent into a loop shape which is cut along one side of the loop to create the crook(2) of a hook with the residual portion(3) of the monofilament loop separated from the hook end tip(7) of the hook to provide a spaced opening(4) sufficient to permit loop(5) to enter and become entangled within the crook(2). In FIG. 6 the dimension "A" of the hook (1) represents the dimension of the return, or height of the crook, while "B" represents the total height of the hook from its base(6) to the top outside of the crook(2). The rectangle "C" of FIG. 6 represents the footprint of material that penetrates into a loop structure when penetration is just sufficient to position tip (7) below the top of a loop. FIG. 2 illustrates what happens when the hook(1) attempts to penetrate into a mat of loops. The top of the hook, having a footprint as shown in FIG. 6 "C", pushes aside the loops(5) and continues to penetrate into the loop pile until it strikes the base of the loop(8). The loops(5), being resilient, spring back and some of the loops enter the space(4) provided by cutting the monofilament. The crook of the hook ensnares the loop which is well within the interior space(9) formed by the monofilament. In this manner the loop becomes ensnared by the hook and when attempting to separate the hook from the loop, separation is restrained by the two components so engaged. To separate the components, the hook must be deflected or

opened. While the force to open an individual hook is small, a proper hook and loop fastener has a sufficient number of hook encounters to require a substantial force to separate the strips.

FIG. 3 shows the same hook penetrating a loop strip which has short loops. The loop height(11) of the low pile type is less than the return of the crook of the hook, dimension "A" in FIG. 6. In such cases the loops are deflected as illustrated in FIG. 3 but the penetration of the hook is stopped when it strikes the base (8) of the loop strip. However, the loops are so short that, regardless of how resilient they may be and regardless of how well they spring back and attempt to enter the space(4) in the hook, their height is insufficient to permit such to take place. The loops are simply unable to get above or around the crook(2) of the hook (1). When this condition prevails there is little or no engagement between the hook and the loops.

FIG. 4 shows a cross section of a plastic molded hook, formed by plastic molding techniques in desired shapes as disclosed in U.S. Pat. No. 4,984,339 assigned to the owner of the instant invention and incorporated by reference herein. In this instance the crook(13) is molded into a similar shape as the crook of the textile monofilament crook(2). However, there is no residual portion(3) to inhibit the movement of loop into and under the crook(13) thus providing a much greater opening (14) than is available from a monofilament textile hook. FIG. 5 is the hook of FIG. 4 engaged with a standard loop. The hook shown has all the features of the hook disclosed in U.S. Pat. No. 4,984,339 which includes the differential tapered profile that results in the setting of the yield point of the hook and permits flexing of the hook during disengagement of the hook from a loop. The combination of the special molded hook shape with small displacement volumes, as will be described in more detail below, provides a novel and especially valuable hook fastener for engaging with low profile loops.

Now turning to FIGS. 6 through 8. As explained above, dimension "A" represents the height of the crook and it is essential the hook penetrate into the mat of loops to a depth at least greater than the height of the crook so that tip (7) will rest below the tops of loops and the loops can spring into the space(9) and be ensnared by the hook. If this does not happen there can be no engagement. The area of loops that must be displaced when the hook penetrates into loops to this point is depicted by the rectangle "C" in each of FIGS. 6, 7, 8, and 9. Rectangle "C" is the cross section of the hook along a plane cut through the hook parallel to the base and tangent to the point on the hook tip that is nearest the base. For example, in FIG. 8 the plane is depicted by dashed line (18) which rests parallel to the base (15), is displaced from the top of the hook by dimension "A" and displaced from the base (15) by dimension "D". It can be readily seen that dimension "D" is equal to "B"−"A". The area of rectangle "C" for any hook will be influenced by several factors. Looking to FIG. 9, the plane(18) cuts through the hook such that the plane is parallel to the base (15), upon which the hook foundation rests, and intersects the back side of the hook at the point(10). Line 20 projects perpendicular to the intersecting plane(18) and because plane (18) is parallel to the base(15), line (20) is also perpendicular to the base(15). If a second line (21) is drawn perpendicular to the plane(18) and also tangent to the outermost edge of the hook tip(7), line (21) will be parallel to line (20). The

lines described define the terminal ends of rectangle "C" (22) and (23). "C" represents the area displaced by the hook in penetrating the mat of loops, or put another way the area to which loops must be pushed aside or displaced for penetration to take place. If the loops into which the hooks penetrate are very resilient, they will immediately bend around such a plane and close in behind the face of the plane. However, if the hook is a solid mass, as in fact it is, the loops simply push back against the walls of the hook. The penetrating hooks have in reality a volume and this volume can simply be defined as the volume of a parallelepiped encasing the crook portion of the hook above the point where penetration is sufficient to enable engagement. FIG. 10 shows the position of the parallelepiped "E" relative to the entire hook configuration. FIG. 11 shows the parallelepipid standing alone. The volume of the parallelepiped can be calculated for a single hook by taking the area "C" and multiplying by the height of the crook "A" where "E"="A"×"C". We have defined this volume as "displacement volume".

We have found this displacement volume is an important factor in determining the ability of a hook to engage with certain types of loops. When the loop height is very low, hooks of low displacement volume show markedly improved performance even though there is more than simple loop height to contend with when determining the ability of a loop to accept a given hook.

The following table shows displacement volume values for a variety of hook types sold by Velcro USA Inc., the assignee of the instant application.

HOOK TYPE	DISPLACEMENT VOLUME	SHEAR IN LOW LOOP
Standard Textile	6.0×10^{-6}	6.5–10.0
Ultra-Mate 15 style	7.4×10^{-6}	5.0–8.0
Molded 3 style	14×10^{-6}	4.0–9.0
Ultra-Mate 24 style	14×10^{-6}	8.0–13.0
Standard Mushroom	1.6×10^{-6}	15.0–20.0
Molded 22 style	1.1×10^{-6}	22.0–29.0

FIG. 12 is a graph depicting the relationship of shear strength of hooks to displacement volumes for hooks engaged in a low profile loop closure system, loop style #3610 sold by Velcro USA Inc. and having loop height of approximately 0.040 inches. This is a fraction of standard loops such as loop 1000 sold by Velcro USA Inc. which has a loop height of approximately 0.100 inches. Data for the graph is taken from the table above to create the plot shown in FIG. 12. The ordinate of the graph of FIG. 12 shows shear strength measured as the strength per square inch of closure. The abscissa shows displacement volume ranging from 1.1×10^{-6} to 24×10^{-6} cubic inches. It is clear from this graph that displacement volume dramatically influences the ability of a hook to perform in the shear mode for this loop design. The shear starts to increase at 6×10^{-6} and rapidly rises to almost double at 4×10^{-6}. For engaging into short fine loops a hook having a displacement volume of less than 6×10^{-6} is desirable but preferably the displacement volume will be less than 4×10^{-6}.

These indicators can be very useful in designing new hook shapes for specific loop geometries. However, hook displacement volume is by no means the only measure to be used in evaluating the ease of engagement of a hook in a low profile loop even though it is one of the important factors. As explained earlier the height of the crook itself influences the displacement volume of

any particular hook, but in addition, the thickness of the hook has a great effect on the displacement volume. In addition, the general shape of the hook can have a major effect on the displacement volume. The hook shape of U.S. Pat. No. 4,984,339 is especially well suited for engagement with low profile loops and the molding process for making that hook is easily adjusted to achieve the modification of the displacement volume and to produce hooks in the preferred range of displacement as disclosed herein. For example, in FIG. 9 the location of the point(10) where the back side of the hook intercepts the lower plane defining the displacement volume sets the dimension of the footprint "C". If the hook has a very shallow rearward slope the point of intersection(10) will be moved rearward also and the displacement volume will be increased. At the crook tip the placement of the hook tip sets the relative position of this same lower plane and the shorter the crook height the lower the displacement volume. It will be appreciated the displacement volume may be adjusted by altering many of the dimensions of the hook shape. Such adjustment is easily accomplished by the methods disclosed in U.S. Pat. No. 4,794,028.

Heretofore this influence of displacement volume on hook and loop performance has not been understood. Hook design has been a matter of trial and error with little rhyme or reason. Hook selection has been primarily a matter of using the materials available and little effort has gone into designing hooks with the specific geometry to accomplish a specific type of performance. It has been known that using a thicker monofilament would result in greater tape separation forces than would be the case if finer monofilaments were used. The development of mushroom tapes and the size of the head is merely a matter of accident. The head was not designed with any specific shape or size intended.

Understanding of the principles of the engagement problem in fine low profile loops has provided the clue to the development of advanced hook products. I have found that plastic molded hooks with a displacement volume of less than about 6×10^{-6}, and preferably less than 4×10^{-6}, engage especially well in loops with a pile height of less than 0.025 inches. Such fine molded hooks have never before been produced. Development of such hooks is a considerable advance in the art, and for the first time, this understanding permits development of hook tapes which are specifically designed for the very desirable aesthetic and cost effective low profile loops.

I claim: